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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: David Mui et al.

Appln No.: 09/905,172

Filed: July 13, 2001

Title: ETCH PATTERN DEFINITION USING A CVD ORGANIC LAYER AS AN ANTI-REFLECTION COATING AND HARDMASK

Art Unit: 1765

Examiner: Deo, Duy Vu Nguy

Confirmation No.: 2748

Docket No.: 004227 USA02/ETCH/SILICON/JB1

Mail Stop Appeal Brief-Patents
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

REPLY BRIEF UNDER 37 CFR §1.193(b)

Dear Sir:

This is a reply pursuant to 37 C.F.R. §1.193(b) in response to the Examiner's Answer mailed on March 10, 2005, in the appeal from the Examiner's decision dated April 13, 2004, finally rejecting Claims 8-11 and 13-40 of the above-referenced patent application.

This Reply Brief is filed within two months of the Examiner's Answer mailed March 10, 2005.

Attached to this Brief as ***Appendix A*** is a copy of all the claims involved in this appeal as required under 37 C.F.R. §1.192(c)(9).

I. *Real Party In Interest.*

The statement contained in the Appeal Brief identifying the real party in interest is incorporated herein by this reference.

II. *Related Appeals and Interferences.*

The statement contained in the Appeal Brief indicating that there are no related appeals or interferences for this application or any related co-pending applications is incorporated herein by this reference.

III. *Status of the Claims*

The statement contained in the Appeal Brief indicating the status of the claims is incorporated herein by this reference.

IV. *Status of Amendments*

The summary of the invention contained in the Appeal Brief is incorporated herein by this reference. As indicated in the Appeal Brief and confirmed in the Examiner's Answer, the Applicants did not amend any of the claims subsequent to the final rejection.

V. *Summary of the Invention*

The summary of the invention contained in the Appeal Brief is incorporated herein by this reference.

VI. *Issues*

1. Whether the invention of Claims 8-11, 13, 15-21, and 27-29 is patentable in light of the rejection under 35 USC 103(a) as being unpatentable over US Patent 6,171,940 (Huang) and 6,452,274 (Hasegawa et al.)

2. Whether the invention of dependent Claims 22-24 is patentable in light of the rejection under 35 USC 103(a) as being unpatentable over the '940 and '274 in view of US Patent 6,083,815 (Tsai et al.).

3. Whether the invention of dependent Claims 25 and 26 is patentable in light of the rejection under 35 USC 103(a) as being unpatentable over the '940 and '274 in view of US Patent 6,200,881 (Lou).

4. Whether the invention of Claims 30, 31, 33, 34 is patentable in light of the rejection under 35 USC 103(a) as being unpatentable over the '940 and '274 in view of US Patent 5,976,769 (Chapman).

5. Whether the invention of Claims 14, 32, and 25-40 is patentable in light of the rejection under 35 USC103(a) as being unpatentable over the '940/'274 or over the '940/'274/'769 in view of US Patent 5,873,984 (Cheng et al.).

VII. *Grouping of Claims*

The grouping of claims contained in the Appeal Brief is incorporated herein by this reference.

VIII. *Argument*

After due consideration of the examiner's answer, appellants believe it is necessary to respond to errors of fact and law that emphasize the erroneous nature of the examiner's rejections.

The legal precedents applicable to the use of necessary hindsight as compared to "undue" hindsight are cited in the principal brief.

The examiner has asserted that the amorphous carbon layer of Hasegawa, which is formed by pyrolysis of acetylene, contains hydrogen, without providing any basis for that assertion. Hasegawa refers to that material as "amorphous carbon," and in the absence of evidence to the contrary, there is no reason to contradict the explicit disclosure of the reference. The examiner's assertion of presumed fact is not of the type that can be taken by official notice. MPEP 2144.03.

The examiner argues that the low k organic layer of Huang is not combined as a mask layer, contending that "the low k organic layer is not a masking layer in the claims but a part of a multiplayer [*sic*] structure that is called [a] masking structure by the applicant" and further arguing that "[i]t is obvious that any structure that has the same layers would also read on [the] claimed masking structure."

The examiner has evidently overlooked the fact that the appealed claims are drawn to processes. Moreover, the "multilayer antireflective hard mask structure" recited in the preamble of claim 8 is etched form a mask in the final process step recited. As part of that step the CVD organic layer is etched through. In claim 17, a substrate structure is etched through apertures in a patterned multilayer mask structure that comprises a dielectric layer over a CVD organic layer, whereas in claim 27 a substrate structure is etched through apertures in a CVD organic layer. Similarly, in claim 30, one or more mask features comprising a dielectric layer disposed over a CVD organic layer are trimmed by a process in which exposed sidewall portions of the CVD

organic layer are etched such that the width of the one or more mask features is reduced at said substrate.

In Huang the "organic layer with low dielectric constant" relied on by the examiner is also part of a mask structure. However the low dielectric constant organic layer of Hasegawa is never part of a mask structure. It itself is never etched through to the underlying substrate, although it may be etched partially through. Other materials are always used as masks. See paragraph 12, line 42, to paragraph 13, line 18, paragraph 14, lines 7-21, paragraph 15, lines 1-3, paragraph 17, lines 1-22, paragraph 19, lines 18-24, and paragraph 20, lines 22-29 and the figures referred to therein.

The examiner has taken a component of Hasegawa that has a function different from that of Huang and the appealed process claims and substituted it for a component having a different function in Huang. For that reason alone the examiner's use of hindsight can be appropriately characterized as "undue." Also for that reason, one skilled in the art would not have had a reasonable expectation for success in making the substitution proposed by the examiner.

IX. *Conclusion*

For the foregoing reasons, in addition to those set forth in the principal brief, it is respectfully submitted that reversal of the examiner's rejection of all claims is in order.

X. *Fees*

The Commissioner is hereby authorized to charge any fees due and owing in this matter to the undersigned attorney's PTO Deposit Account No. 50-1047.

Respectfully submitted,

David B. Bonham Reg. No. 34,297

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XI. APPENDIX A

The claims involved in the appeal, Claims 8-11 and 13-40 are reproduced below.

Claims 1-7 (cancelled).

8. (Previously presented) A method of forming a multilayer antireflective hard mask structure, said method comprising:

providing a substrate structure;

depositing a CVD organic layer over said substrate structure by a plasma enhanced chemical vapor deposition process using a feed stream that comprises a hydrocarbon species, said CVD organic layer comprising carbon and hydrogen;

depositing a dielectric layer over said CVD organic layer;

providing a patterned organic photoresist layer over said dielectric layer;

etching said dielectric layer through apertures in said patterned photoresist layer in a first plasma etching step until apertures are formed in said dielectric layer; and

etching said CVD organic layer through said apertures in said dielectric layer in a second plasma etching step until apertures are formed in said CVD organic layer.

9. (Original) The method of claim 8, wherein said dielectric layer is a silicon oxynitride layer.

10. (Original) The method of claim 9, wherein said first plasma etching step is conducted using a plasma source gas that comprises a halogen containing species.

11. (Original) The method of claim 10, wherein said first plasma etching step is conducted using a plasma source gas that comprises a fluorocarbon containing species.

12. (Cancelled)

13. (Previously presented) The method of claim 1, wherein said hydrocarbon species is propylene gas.

14. (Previously presented) The method of claim 1, wherein said feed stream further comprises N_2 gas.

15. (Original) The method of claim 8, wherein said second plasma etching step is conducted using a plasma source gas that comprises an oxygen containing species.

16. (Original) The method of claim 15, wherein said oxygen containing species is O_2.

17. (Previously presented) A method of etching a substrate structure comprising:

providing a substrate structure;

providing a patterned multilayer mask structure over said substrate structure, said patterned multilayer mask structure having apertures and comprising: (a) a CVD organic layer comprising carbon and hydrogen deposited over said substrate structure by a plasma enhanced chemical vapor deposition process using a feed stream that comprises a hydrocarbon species and (b) a dielectric layer over said CVD organic layer; and

etching said substrate structure through said apertures by a plasma etching process.

18. (Original) The method of claim 17, further comprising removing remnants of said CVD organic layer after said substrate structure is etched.

19. (Original) The method of claim 18, wherein said remnants are removed by a plasma etching process in the presence of a plasma source gas that comprises an oxygen containing species.

20. (Original) The method of claim 19, wherein said oxygen containing species is O_2.

21. (Original) The method of claim 17, wherein said substrate structure comprises a silicon layer and wherein said silicon layer is etched in the course of said plasma etching process.

22. (Original) The method of claim 21, wherein said plasma etching process comprises a plasma etching step that utilizes a plasma source gas composition comprising a halogen containing species.

23. (Original) The method of claim 21,

wherein said substrate structure comprises a single crystal silicon layer, an oxide layer over said single crystal silicon layer, a doped polycrystalline silicon layer over said oxide layer and a native oxide layer over said doped polycrystalline silicon layer, and

wherein said native oxide layer and said doped polycrystalline silicon layer are etched by said plasma etching process.

24. (Original) The method of claim 23, wherein said plasma etching process comprises two or more plasma etching steps and wherein each of the two or more plasma etching steps utilizes a plasma source gas composition that comprises a halogen containing species.

25. (Original) The method of claim 21,

wherein said substrate structure comprises a single crystal silicon layer, an oxide layer over said single crystal silicon layer and a silicon nitride layer over said oxide layer, and

wherein said single crystal silicon layer, said oxide layer, and said silicon nitride layer are etched by said plasma etching process.

26. (Previously presented) The method of claim 25, wherein said plasma etching process comprises (a) one or more plasma etching steps that utilize a plasma source gas composition

comprising an oxygen containing species and (b) one or more plasma etching steps that utilize a plasma source gas composition comprising a halogen containing species.

27. (Previously presented) A method of etching a substrate structure comprising:

providing a substrate structure;

providing a CVD organic layer comprising carbon and hydrogen over said substrate structure by a plasma enhanced chemical vapor deposition process using a feed stream that comprises a hydrocarbon species, said CVD organic layer having apertures therein; and

etching said substrate structure through said apertures by a plasma etching process.

28. (Original) The method of claim 27, further comprising removing remnants of said CVD organic layer after said substrate structure is etched by a plasma etching process in the presence of a plasma source gas that comprises an oxygen containing species.

29. (Original) The method of claim 28, wherein said oxygen containing species is O_2.

30. (Previously presented) A method for trimming a mask feature comprising:

providing one or more mask features on a substrate structure, each said mask feature comprising (a) a CVD organic layer comprising carbon and hydrogen deposited on said substrate structure by a plasma enhanced chemical vapor deposition process using a feed stream that comprises a hydrocarbon species, and (b) a dielectric layer disposed over said CVD organic layer such that sidewall portions of said CVD organic layer are exposed; and

etching said exposed sidewall portions of said CVD organic layer by means of a plasma etching process such that the width of said one or more mask features is reduced at said substrate.

31. (Original) The method of claim 30, wherein said dielectric layer is a silicon oxynitride layer.

32. (Original) The method of claim 30, wherein said CVD organic layer comprises 70-80 % carbon, 10-20% hydrogen and 5-15% nitrogen.

33. (Original) The method of claim 30, wherein said CVD organic layer is etched using a plasma source gas that comprises an oxygen containing species.

34. (Original) The method of claim 33, wherein said oxygen containing species is O_2.

35. (Previously presented) The method of claim 8, wherein said CVD organic layer comprises 70-80 % carbon, 10-20% hydrogen and 5-15% nitrogen.

36. (Previously presented) The method of claim 8, wherein said dielectric layer is a silicon oxynitride layer and wherein said CVD organic layer comprises 70-80% carbon, 10-20% hydrogen and 5-15% nitrogen.

37. (Previously presented) The method of claim 17, wherein said CVD organic layer comprises 70-80 % carbon, 10-20% hydrogen and 5-15% nitrogen.

38. (Previously presented) The method of claim 17, wherein said dielectric layer is a silicon oxynitride layer and wherein said CVD organic layer comprises 70-80% carbon, 10-20% hydrogen and 5-15% nitrogen.

39. (Previously presented) The method of claim 27, wherein said CVD organic layer comprises 70-80 % carbon, 10-20% hydrogen and 5-15% nitrogen.

40. (Previously presented) The method of claim 30, wherein said dielectric layer is a silicon oxynitride layer and wherein said CVD organic layer comprises 70-80% carbon, 10-20% hydrogen and 5-15% nitrogen.